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Original Article

Association between lower urinary tract symptoms and cigarette smoking or alcohol drinking

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Background: Although there have been several studies about the relationship between alcohol or smoking and lower urinary tracts symptoms (LUTS). This study aimed to investigate the association between alcohol or smoking and severity of LUTS in men, as alcohol intake and cigarette smoking is important modifiable lifestyle factors for LUTS.

Methods: A cross-sectional analysis has been performed and a total of 86,707 participants in Korean Community Health Survey were included for final analysis. The adjusted odds ratio (OR) or coefficient with 95% confidence interval (CI) estimates were described to show the association between alcohol consumption or cigarette smoking and LUTS.

Results: Among the total subjects, 77,398 (89.3%), 7,532 (8.7%), and 1,777 (2.0%) had mild, moderate, and severe symptoms, respectively, according to International Prostate Symptom Score (IPSS) grade. Those who drank alcohol at least once per month were significantly associated with decreased risk of having the worst IPSS grade (OR: 0.80, 95% CI: 0.68 to 0.93). Those who smoked in the past but currently quitted and those who were daily smokers showed significantly increased risk of having the worst IPSS grade (past smoker, OR: 1.26, 95% CI: 1.14 to 1.39; daily smoker, OR: 1.21, 95% CI: 1.10 to 1.34). For nocturia, daily smoking showed positive effect (OR: 0.79, 95% CI: 0.75 to 0.84) whereas heavy alcohol drinking showed negative effect (OR: 1.22, 95% CI: 1.14 to 1.32)

Conclusions: Alcohol showed positive effect on LUTS except nocturia whereas cigarette smoking had negative effect on LUTS except nocturia. Daily smoking showed positive effect on nocturia whereas heavy alcohol drinking showed negative effect on nocturia.

Keywords: Alcohol; smoking; prostatic hyperplasia; lower urinary tract symptoms

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Introduction

Traditionally, male lower urinary tract symptoms (LUTS) has been regarded as main problem of benign prostate hyperplasia (BPH) while female LUTS has been regards as overactive bladder (OAB). However, there are emerging evidences showing that not only biological factors of BPH and OAB, but also modifiable lifestyle factors could affect LUTS (1,2). Constructing changes in these modifiable lifestyle factors are important because there could be a potential treatment to control non-urological origin. However, only a few studies have focused on the efficacy of changing modifiable lifestyle factors including water restriction and weight loss in relation with nocturia and stress urinary incontinence (2-5).

The main reason for few studies on the efficacy of changing modifiable lifestyle factors by prospective trials lies on inconsistent results from many observational studies. Before medication treatment, patients are generally educated to modify their lifestyle factors including changing volume of fluid intake, less caffeine, and less alcohol (1). However, these recommendations could only be adopted by limited portion of patients with LUTS. For better and broader application of changing lifestyle factors, more reliable evidences are needed.

Among different lifestyle factors, cigarette smoking and alcohol drinking have shown inconsistent results regarding their effects on LUTS. Recently, one systematic review study has concluded that modest alcohol intake is a favorable factor for BPH/LUTS (2). However, excessive alcohol intake could lead to worse LUTS compared than less alcohol intake (2). About the relationship between cigarette smoking and LUTS, conclusion could not be made due to too few studies and inconsistent results (2).

Considering the importance of cigarette smoking and alcohol intake for general health of our entire body, more objective studies are needed using large population sample to validate their relationships with LUTS. The objective of the present study was to investigate the relationship of LUTS severity with cigarette smoking and alcohol intake using validated questionnaire.

Methods

Data and subjects

This study used data obtained from the 2011 Korean Community Health Survey (KCHS). The KCHS is a nationwide public health survey annually conducted since 2008 by the Korean Centers for Disease Control and Prevention. The purpose of KCHS is to estimate community-based health statistics, morbidity, and prevalence of diseases among Korean adults. The KCHS adopted a multi-stage sampling design to ensure that the sampling unit was representative of the nation's population. In the first stage, a primary sampling unit (district, town, and village) was extracted according to the number of households in each of the smallest governmental administrative units. A probability proportionate to the size sampling method was used when extracting samples. In the second stage, average of five sample households was extracted using systematic sampling methods at selected sampling point and every member of a household who was 19 years or older was interviewed. This study was ultimately carried out using data from 86,707 subjects after excluding 142,519 respondents who were females (N=126,209), who reported currently receiving treatment with prostatic hyperplasia (N=4,745) to prevent bias that might affect LUTS, and who had missing data for International Prostate Symptom Score (IPSS), dietary behavior variables, or covariates (N=11,565) from 229,226 participants originally included in the 2011 KCHS (*Figure 1*).

Variables and measurements

This study measured the LUTS of survey participants based on responses from the Korean version of IPSS Questionnaire on KCHS, one of the most widely used tools for evaluating LUTS. As independent variables, frequency of alcohol consumption and smoking status were measured by self-reported questionnaires. Alcohol consumption frequency was classified into "non-drinker", "drink less than once per month", "drink two to four times per month", "drink two to three times per week", and "drink four or more times per week". Smoking status was determined by four categories: daily smoker, non-daily smoker, former smoker (smoked in the past but currently quitted), and never smoker (individuals who had smoked fewer than 100 cigarettes in their lifetime). Dependent variables were IPSS grade {mild: IPSS total [0–7], moderate [8–19], severe [20–35]}, IPSS voiding [sum of IPSS Q1 (incomplete emptying), Q3 (intermittency), Q5 (weak stream), Q6 (straining); 5 or higher score categorized as having symptoms], IPSS storage [sum of IPSS Q2 (frequency), Q4 (urgency), Q7 (nocturia); 4 or higher score categorized as having symptoms], and nocturia (IPSS Q7; 1 or higher score categorized as having symptoms).

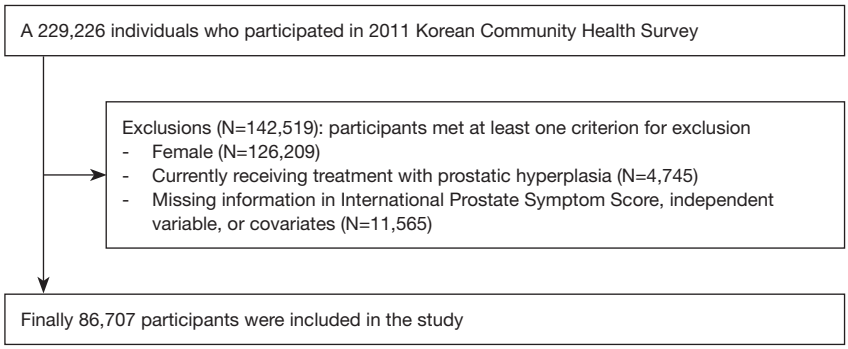

Figure 1 Schematic diagram of the study subject selection.

Socio-demographic factors and comorbidities were considered as covariates. Socio-demographic variables included age, marital status, education level, household income, and residence. Age was divided into "19–29", "30–39", "40–49", "50–59", "60–69", "70–79", "80–89", and "90 or higher". Marital status was classified into "married", "separated, divorced, or widowed", and "never married". Education level was classified into "elementary school graduate or lower", "middle school graduate", "high school graduate", and "college graduate or higher". Household income was divided according to quartiles. Residence was based on 16 governmental administrative districts and assigned as "capital" (Seoul), "urban" (6 metropolitan cities were included; Busan, Daegu, Incheon, Gwangju, Daejeon, and Ulsan), or "rural" (rest of capital and urban regions were included: Gyeonggi, Gangwon, Chungbuk, Chungnam, Chungbuk, Chungnam, Jeonbuk, Jeonnam, Gyeongbuk, Gyeongnam, and Jeju). Comorbidities considered hypertension, diabetes mellitus, and dyslipidemia, the most prevalent chronic diseases in Korean adults. They were determined based on physician's diagnosis.

Statistical analysis

Descriptive analysis was performed to summarize LUTS and socio-demographic characteristics of the study population. The frequency and percentage by IPSS grade were reported. To analyze group differences, a Chi-squared test was conducted. Ordinal logistic regression (for the IPSS grade) and binomial logistic regression (for the IPSS voiding, storage, and nocturia symptoms) were performed to identify the relationship between LUTS measured by IPSS and alcohol consumption or smoking among Korean male adults after controlling for independent variables and covariates. Adjusted odds ratio (OR) with 95% confidence interval (CI) estimates were reported and threshold for statistical significance was set at 5% (two-tailed). All analysis applied benchmark weight provided from KCHS to adjust for complex sampling design to produce reliable design-based estimates and ensure national representativeness. Data were analyzed in Stata version 14.2 (StataCorp LP, College Station, TX, USA).

Ethics statement

Procedures of this study were reviewed and approved by the Institutional Review Board of Soonchunhyang University Seoul Hospital with a waiver for informed consent (2018-12-011). KCHS data are openly accessible at national public repository (http://chs.cdc.go.kr). There were no confidentiality risks to participants of this study because all KCHS data were deidentified.

Results

Table 1 summarizes socio-demographic and LUTS characteristics of study subjects. Of a total of 86,707 study subjects, 77,398 (89.3%), 7,532 (8.7%), and 1,777 (2.0%) had mild, moderate, and severe symptoms, respectively, according to IPSS grade. Those who were older, separated, divorced or widowed in marital status, with lower education level or household income, residing in rural region, having hypertension, diabetes mellitus, or dyslipidemia, smoked in past but currently quitted, non-drinker or drinking four or more times per week tended to be have worse condition based on IPSS grade compared to their counterparts. The distribution of study subjects by IPSS grade showed

Table 1 Characteristics of study participants by International Prostate Symptom Score (IPSS) grade

Variable	Subcategory	IPSS grade						Total		Pearson χ^2	P value
		Mild		Moderate		Severe					
		N	%	N	%	N	%	N	%		
Age	19–29	10,514	98.7	132	1.2	10	0.1	10,656	100.0	1.50E+04	<0.01
	30–39	15,126	98.2	259	1.7	19	0.1	15,404	100.0		
	40–49	18,135	96.7	543	2.9	71	0.4	18,749	100.0		
	50–59	16,160	92.0	1,219	6.9	178	1.0	17,557	100.0		
	60–69	10,682	80.6	2,151	16.2	415	3.1	13,248	100.0		
	70–79	5,766	63.8	2,509	27.8	759	8.4	9,034	100.0		
	80–89	961	49.8	680	35.2	290	15.0	1,931	100.0		
	90 or higher	54	42.2	39	30.5	35	27.3	128	100.0		
Marital status	Married	55,932	88.0	6,230	9.8	1,421	2.2	63,583	100.0	1.70E+03	<0.01
	Separated, divorced, widowed	5,578	81.6	952	13.9	302	4.4	6,832	100.0		
	Unmarried	15,888	97.5	350	2.1	54	0.3	16,292	100.0		
Education level	Elementary graduate or lower	2,527	62.9	1,067	26.6	423	10.5	4,017	100.0	7.90E+03	<0.01
	Middle school graduate	8,871	74.9	2,310	19.5	666	5.6	11,847	100.0		
	High school graduate	9,046	84.7	1,365	12.8	265	2.5	10,676	100.0		
	College graduate or higher	56,954	94.7	2,790	4.6	423	0.7	60,167	100.0		
Household income	1st quartile (lowest)	14,777	75.3	3,689	18.8	1,163	5.9	19,629	100.0	5.70E+03	<0.01
	2nd quartile	25,000	90.9	2,106	7.7	396	1.4	27,502	100.0		
	3rd quartile	20,444	95.0	970	4.5	116	0.5	21,530	100.0		
	4th quartile (highest)	17,177	95.2	767	4.3	102	0.6	18,046	100.0		
Residence	Capital	7,417	90.6	662	8.1	105	1.3	8,184	100.0	148.40	<0.01
	Urban	16,162	91.3	1,248	7.1	287	1.6	17,697	100.0		
	Rural	53,819	88.5	5,622	9.2	1,385	2.3	60,826	100.0		
Hypertension	No	63,319	91.7	4,666	6.8	1,029	1.5	69,014	100.0	2.20E+03	<0.01
	Yes	14,079	79.6	2,866	16.2	748	4.2	17,693	100.0		
Diabetes mellitus	No	71,734	90.3	6,247	7.9	1,436	1.8	79,417	100.0	1.10E+03	<0.01
	Yes	5,664	77.7	1,285	17.6	341	4.7	7,290	100.0		
Dyslipidemia	No	70,778	89.7	6,569	8.3	1,566	2.0	78,913	100.0	168.76	<0.01
	Yes	6,620	84.9	963	12.4	211	2.7	7,794	100.0		

Table 1 (*continued*)

Table 1 (*continued*)

Variable	Subcategory	IPSS grade						Total		Pearson χ^2	P value
		Mild		Moderate		Severe					
		N	%	N	%	N	%	N	%		
Alcohol consumption	Non-drinker	13,683	80.2	2,588	15.2	787	4.6	17,058	100.0	2.70E+03	<0.01
	Less than once per month	6,540	89.3	647	8.8	137	1.9	7,324	100.0		
	Once per month	5,997	92.8	401	6.2	66	1.0	6,464	100.0		
	2 to 4 times per month	20,153	94.1	1,070	5.0	203	0.9	21,426	100.0		
	2 to 3 times per week	19,389	93.1	1,242	6.0	189	0.9	20,820	100.0		
	4 or more times per week	11,636	85.5	1,584	11.6	395	2.9	13,615	100.0		
Smoking	Never smoker	18,394	91.6	1,394	6.9	303	1.5	20,091	100.0	1.30E+03	<0.01
	Former smoker	23,016	83.8	3,567	13.0	896	3.3	27,479	100.0		
	Non-daily smoker	2,168	92.6	137	5.8	37	1.6	2,342	100.0		
	Daily smoker	33,820	91.9	2,434	6.6	541	1.5	36,795	100.0		
IPSS voiding	No	76,317	97.9	1,653	2.1	–	0.0	77,970	100.0	6.10E+04	<0.01
	Yes	1,081	12.4	5,879	67.3	1,777	20.3	8,737	100.0		
IPSS storage	No	74,574	97.4	1,976	2.6	40	0.1	76,590	100.0	4.60E+04	<0.01
	Yes	2,824	27.9	5,556	54.9	1,737	17.2	10,117	100.0		
IPSS nocturia	No	50,887	98.4	773	1.5	69	0.1	51,729	100.0	1.10E+04	<0.01
	Yes	26,511	75.8	6,759	19.3	1,708	4.9	34,978	100.0		

significant differences in all independent variables and covariates (all P<0.01).

Results of multivariable analysis on IPSS grade, voiding, storage, and nocturia symptoms are shown in *Tables 2–5*, respectively. Those who smoked in the past but currently quitted and those who were daily smokers showed significantly increased risk of having the worst IPSS grade (past smoker, OR: 1.26, 95% CI: 1.14 to 1.39, P<0.01; daily smoker, OR: 1.21, 95% CI: 1.10 to 1.34, P<0.01; *Table 2*), having voiding symptoms (past smoker, OR: 1.31, 95% CI: 1.19 to 1.45, P<0.01; daily smoker, OR: 1.31, 95% CI: 1.18 to 1.46, P<0.01; *Table 3*), and having storage symptoms (past smoker, OR: 1.19, 95% CI: 1.08 to 1.30, P<0.01; daily smoker, OR: 1.13, 95% CI: 1.03 to 1.24; P=0.01; *Table 4*) compared to subjects who never smoked. Regarding nocturia symptoms, past smoker showed increased risk of having nocturia symptoms (OR: 1.09, 95% CI: 1.03 to 1.15, P<0.01). However, daily smoker showed significantly decreased risk of having nocturia symptoms compared to subjects who were never smokers (OR: 0.79, 95% CI: 0.75 to 0.84, P<0.01) (*Table 5*).

Those who drank alcohol at least once per month were significantly associated with decreased risk of having the worst IPSS grade (once per month, OR: 0.80, 95% CI: 0.68 to 0.93, P<0.01; 2 to 4 times per month, OR: 0.72, 95% CI: 0.65 to 0.80, P<0.01; 2 to 3 times per week, OR: 0.80, 95% CI: 0.72 to 0.89, P<0.01; 4 or more times per week, OR: 0.90, 95% CI: 0.81 to 0.99, P=0.03, *Table 2*), having voiding symptoms (once per month, OR: 0.82, 95% CI: 0.70 to 0.95, P=0.01; 2 to 4 times per month, OR: 0.80, 95% CI: 0.72 to 0.90, P<0.01; 2 to 3 times per week, OR: 0.79, 95% CI: 0.71 to 0.88, P<0.01; 4 or more times per week, OR: 0.90, 95% CI: 0.81 to 0.99, P=0.03; *Table 3*), and having storage symptoms (once per month, OR: 0.80, 95% CI: 0.69 to 0.93,

Table 2 Association between alcohol consumption or smoking and IPSS grade

Variables	Subcategory	IPSS grade (mild, moderate, severe) (reference = mild)				
		OR	Linearized SE	P value	95% CI	
Alcohol consumption	Non-drinker	1.00	Ref			
	Less than once per month	0.96	0.06	0.52	0.84	1.09
	Once per month	0.80	0.06	<0.01	0.68	0.93
	2 to 4 times per month	0.72	0.04	<0.01	0.65	0.80
	2 to 3 times per week	0.80	0.04	<0.01	0.72	0.89
	4 or more times per week	0.90	0.04	0.03	0.81	0.99
Smoking	Never smoker	1.00	Ref			
	Former smoker	1.26	0.06	<0.01	1.14	1.39
	Non-daily smoker	1.03	0.13	0.78	0.81	1.32
	Daily smoker	1.21	0.06	0.00	1.10	1.34
Threshold (moderate)	–	3.26	0.17	0.00	2.93	3.58
Threshold (severe)	–	5.33	0.17	0.00	5.00	5.66

The KCHS as a sample survey was analyzed by study subject and with applied weight calculated in production of the sample design weight and benchmark weight. Strata with single sampling unit centered at overall mean. Sample size =86,707, weighted =16,625,969. Model adjusted for age, marital status, education level, household income, residence, hypertension, diabetes mellitus, and dyslipidemia. KCHS, Korean Community Health Survey; IPSS, International Prostate Symptom Score; OR, odds ratio; CI, confidence interval; SE, standard error; Ref, reference.

Table 3 Association between alcohol consumption or smoking and IPSS voiding

Variable	Subcategory	IPSS voiding (yes =5 or higher) (reference = no)				
		OR	Linearized SE	P value	95% CI	
Alcohol consumption	Non-drinker	1.00	Ref			
	Less than once per month	1.00	0.07	0.95	0.88	1.14
	Once per month	0.82	0.06	0.01	0.70	0.95
	2 to 4 times per month	0.80	0.04	<0.01	0.72	0.90
	2 to 3 times per week	0.79	0.04	<0.01	0.71	0.88
	4 or more times per week	0.90	0.05	0.03	0.81	0.99
Smoking	Never smoker	1.00	Ref			
	Former smoker	1.31	0.07	<0.01	1.19	1.45
	Non-daily smoker	1.13	0.14	0.34	0.88	1.44
	Daily smoker	1.31	0.07	<0.01	1.18	1.46

The KCHS as a sample survey was analyzed by study subject and with applied weight calculated in production of the sample design weight and benchmark weight. Strata with single sampling unit centered at overall mean. Sample size =86,707, weighted =16,625,969. Model adjusted for age, marital status, education level, household income, residence, hypertension, diabetes mellitus, and dyslipidemia. KCHS, Korean Community Health Survey; IPSS, International Prostate Symptom Score; OR, odds ratio; CI, confidence interval; SE, standard error; Ref, reference.

Table 4 Association between alcohol consumption or smoking and IPSS storage

Variable	Subcategory	IPSS Storage (yes =4 or higher) (reference = no)				
		OR	Linearized SE	P value	95% CI	
Alcohol consumption	Non-drinker	1.00	Ref			
	Less than once per month	0.93	0.06	0.28	0.82	1.06
	Once per month	0.80	0.06	0.01	0.69	0.93
	2 to 4 times per month	0.77	0.04	<0.01	0.69	0.85
	2 to 3 times per week	0.81	0.04	<0.01	0.74	0.90
	4 or more times per week	0.95	0.05	0.32	0.87	1.05
Smoking	Never smoker	1.00	Ref			
	Former smoker	1.19	0.06	<0.01	1.08	1.30
	Non-daily smoker	1.21	0.14	0.11	0.96	1.53
	Daily smoker	1.13	0.05	0.01	1.03	1.24

The KCHS as a sample survey was analyzed by study subject and with applied weight calculated in production of the sample design weight and benchmark weight. Strata with single sampling unit centered at overall mean. Sample size =86,707, weighted =16,625,969. Model adjusted for age, marital status, education level, household income, residence, hypertension, diabetes mellitus, and dyslipidemia. KCHS, Korean Community Health Survey; IPSS, International Prostate Symptom Score; OR, odds ratio; CI, confidence interval; SE, standard error; Ref, reference.

Table 5 Association between alcohol consumption or smoking and nocturia

Variable	Subcategory	IPSS Nocturia (yes =1 or higher) (reference = no)				
		OR	Linearized SE	P value	95% CI	
Alcohol consumption	Non-drinker	1.00	Ref			
	Less than once per month	1.06	0.05	0.18	0.97	1.15
	Once per month	1.08	0.05	0.10	0.99	1.18
	2 to 4 times per month	1.07	0.04	0.03	1.01	1.15
	2 to 3 times per week	1.13	0.04	<0.01	1.06	1.21
	4 or more times per week	1.22	0.05	<0.01	1.14	1.32
Smoking	Never smoker	1.00	Ref			
	Former smoker	1.09	0.03	<0.01	1.03	1.15
	Non-daily smoker	0.95	0.06	0.40	0.83	1.08
	Daily smoker	0.79	0.02	<0.01	0.75	0.84

The KCHS as a sample survey was analyzed by study subject and with applied weight calculated in production of the sample design weight and benchmark weight. Strata with single sampling unit centered at overall mean. Sample size =86,707, weighted =16,625,969. Model adjusted for age, marital status, education level, household income, residence, hypertension, diabetes mellitus, and dyslipidemia. KCHS, Korean Community Health Survey; IPSS, International Prostate Symptom Score; OR; odds ratio; CI, confidence interval; SE, standard error; Ref, reference.

P=0.01; 2 to 4 times per month, OR: 0.77, 95% CI: 0.69 to 0.85, P<0.01; 2 to 3 times per week, OR: 0.81, 95% CI: 0.74 to 0.90, P<0.01; *Table 4*) compared to subjects in the non-drinker group. On the other hand, those who drank alcohol at least twice per month were significantly associated with increased risk of having nocturia symptoms compared to subjects in the non-drinker group (2 to 4 times per month, OR: 1.07, 95% CI: 1.01 to 1.15, P=0.03; 2 to 3 times per week, OR: 1.13, 95% CI: 1.06 to 1.21, P<0.01; 4 or more times per week, OR: 1.22, 95% CI: 1.14 to 1.32; *Table 5*).

Discussion

The main focus of this study was to investigate relationships of LUTS with cigarette smoking and alcohol intake using large national representative population data so that more firmed evidence about their relationship could be obtained. Considering conflicting findings about their relationships, this study could provide supportive information by overcoming low population-based sample issue of previous studies. Our results suggest a positive role of alcohol drinking and a negative role of cigarette smoking on diverse LUTS categories including general LUTS (IPSS severity), storage LUTS, and voiding LUTS. The most interesting finding of this study is that cigarette smoking and alcohol intake could affect nocturia. This is a novel finding. Only limited literature has scope of this finding.

Although one recent systematic review concluded that modest alcohol intake was a positive factor for male LUTS as it decreased the risk of LUTS compared to non-drinking as moderate alcohol intake was associated with decreased risk of BPH diagnosis and undergoing surgery (2), two large longitudinal prospective studies showed opposite findings (6,7). One study showed that daily alcohol drinking had no effect on LUTS severity in their 4-year follow-up study (6) while another study showed a positive effect of alcohol drinking on LUTS severity in their 7-year follow-up study (7). However, heavy alcohol intake had negative effect on LUTS including incontinence, voiding, and storage LUTS (4). This J-shaped association between alcohol intake and LUTS severity was also found in a large population study (8). It reported that the risk for moderate and severe LUTS was the lowest in modest drinkers but the highest in heavy drinkers compared to non-drinkers (8).

Our study showed a positive effect of alcohol intake on LUTS severity by IPSS grade. Not only moderate drinkers, but also heavy drinkers (alcohol consumption: 4 or more times per week) showed significantly reduced risk for LUTS severity. Alcohol intake also had positive effects on voiding LUTS and storage LUTS. Among LUTS, association between alcohol intake and OAB showed more inconsistent results that that between alcohol intake and general LUTS. In two large population studies, one study showed negative role of alcohol intake in OAB (9) while the other study did not show any association (10). In our study, alcohol intake showed a positive role in storage LUTS by IPSS, even heavy drinkers showed decreasing OR for storage LUTS, although the decrease was not statistically significant.

There are only a few studies about the relationship between alcohol intake and nocturia. One cohort study showed no association between alcohol intake and nocturia (9). However, another study showed that modest alcohol intake was associated with lower risk of nocturia (11). In our study, alcohol intake showed negative effect of any level of drinking on nocturia. All results were statistically significant findings compared to non-alcohol drinkers. Our study is the first one to show a negative effect of alcohol intake on nocturia.

Possible mechanisms for the relationship between alcohol intake and LUTS include increased sympathetic tone activity, diuretic effect, and changed androgen levels (12,13). Positive effect of alcohol intake on LUTS could be explained by diuretic effect and low androgen level while negative effect could be explained by diuretic effect and increased sympathetic tone activity. Diuretic effect could serve as both positive and negative factor in the effect of alcohol intake on LUTS. Individual differences in genetic polymorphism of the aldehyde dehydrogenase 2 (ALDH2) gene might also have associations with BPH (14).

The relationship between cigarette smoking and LUTS has more limited evidence than that between alcohol and LUTS. Several studies have shown a negative effect of cigarette smoking on LUTS (2), although other studies have shown no association between the degree of smoking and LUTS (12,15). In our study, cigarette smoking showed negative effect on all LUTS except nocturia. The degree of smoking was also related to the severity of LUTS in that it had negative effects on all LUTS except nocturia.

The possible mechanism for the effect of cigarette smoking on LUTS has been investigated in many experimental studies. These studies have suggested that cigarette smoking could increase androgen level (16,17), increase the sympathetic tone activity by nicotine receptor (18,19), and cause imbalance in hormone and nutrient between muscle and collagen (20). Other studies support that the negative effect of cigarette smoking on nocturia is especially related to metabolic syndrome (21). However,

Bing *et al.* (22) in their Danish population study reported that smoking was inversely associated with nocturia in both crude and adjusted models. Although significance disappeared compared to severe nocturia of ≥2 or ≥3 voids per night, the significance appeared in the ordinal logistic model. Seim *et al.* (23) have also reported an inverse association between smoking and nocturia, supporting a positive or protective effect of smoking on nocturia. Although we could not adjust metabolic syndrome factor, smoking was inversely associated with nocturia after adjustment of possible covariates including body mass index (BMI). This protective effect of smoking could be explained by increased arginine vasopressin due to increased nicotine, thus decreasing nocturnal urine production (24,25).

Although we have performed a thorough analysis, this study still has several limitations. First, cross-sectional study design hampered the establishment of a causal effect of alcohol intake or cigarette smoking on the severity of LUTS. Second, subjective questionnaire was used to access the degree of alcohol intake and cigarette smoking. However, estimating the degree of drinking and smoking without questionnaire is difficult. Lastly, these data did not include biological data including prostate size or chemistry profiles. They did not include objective measurement of LUTS such as uroflowmetry or frequency volume chart either.

Conclusions

This large population-based study suggests updated evidence about relationships of LUTS with alcohol intake and cigarette smoking. Alcohol showed positive effect on LUTS except nocturia whereas cigarette smoking had negative effect on LUTS except nocturia. Alcohol increased the risk of nocturia while smoking decreased the risk of nocturia. Further evidence using prospective trial is needed to support our study findings.

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Footnote

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/tau.2020.03.07). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. Procedures of this study were reviewed and approved by the Institutional Review Board of Soonchunhyang University Seoul Hospital with a waiver for informed consent (2018-12-011). KCHS data are openly accessible at national public repository (http://chs.cdc.go.kr). There were no confidentiality risks to participants of this study because all KCHS data were deidentified.

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